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Office of Energy Efficiency & Renewable Energy

National Renewable Energy Laboratory

Innovation for Our Energy Future

Western Wind and Solar Integration Study

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NREL

NM RETA Board Meeting
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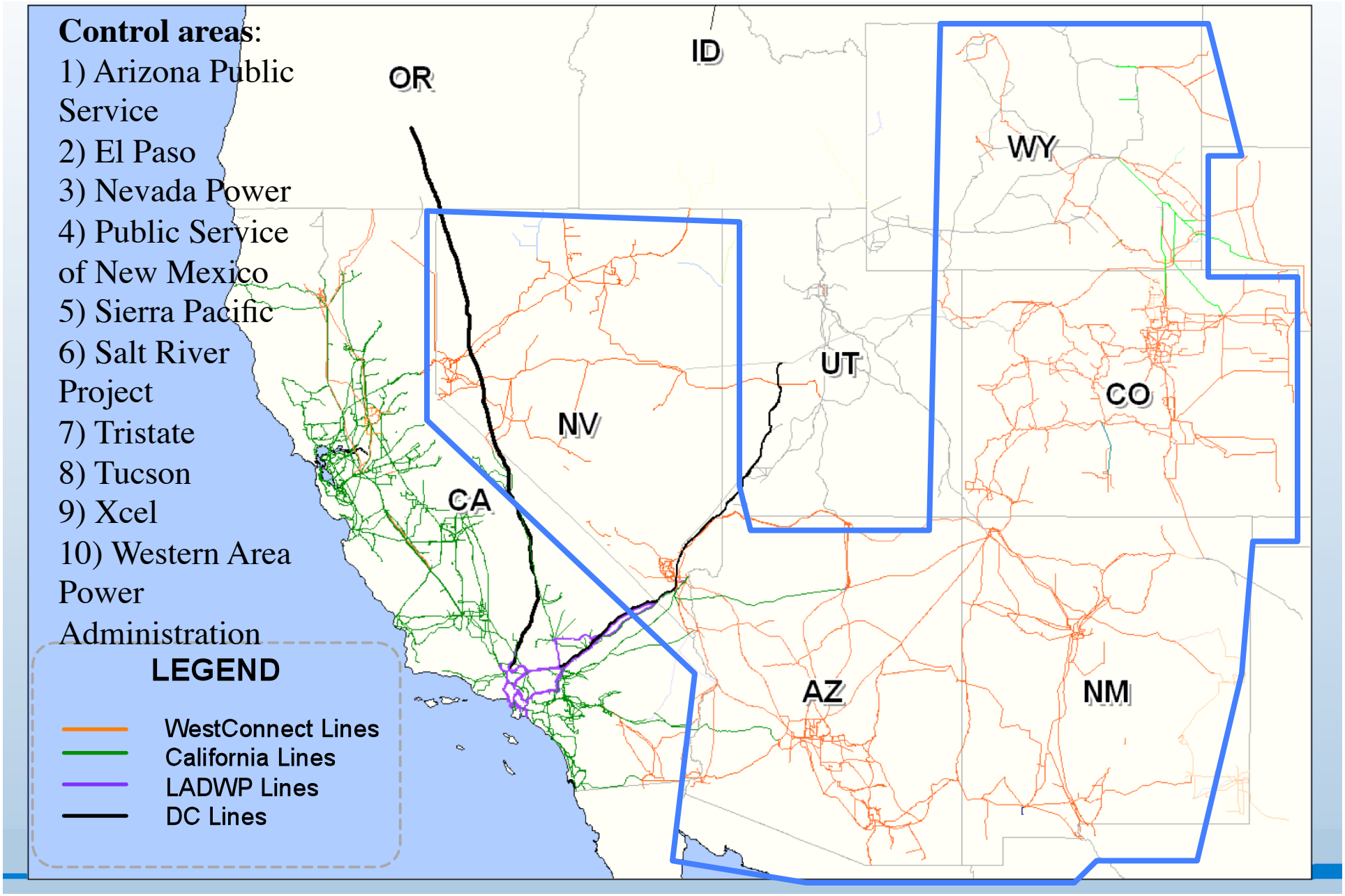
earch Institute • Battelle

Why undertake a regional integration study?

- DOE/NREL/AWEA's 20% Wind by 2030 Scenario
  - 20% scenario needs 25% wind in WECC
- Western Governor's Association Clean and Diversified Energy Initiative
- WestConnect's Virtual Control Area Study
- RPS targets in most of WestConnect states and rapid growth in wind/solar expected in this region

Study Footprint (WestConnect outside of California)



Overview

- Goal
  - To understand the costs and operating impacts due to the variability and uncertainty of wind, PV and concentrating solar power (CSP) on the grid
  - Not the cost of wind or solar generation
- Issues
  - Does geographic diversity help?
  - How do local resources compare to out-of-state resources
  - Can balancing area cooperation help manage variability?
- Scope of study
  - Operations, not transmission study
  - Study year – 2017 to line up with WECC studies
  - Simulate load and climate patterns of 2004, 2005, 2006 forecast out to 2017
  - Simulate all of WECC but all subhourly variability accommodated by WestConnect

High Renewables Basecase 2017

	Wind	Solar PV	Concentrating Solar Power	Total
Study footprint (WestConnect)	30% by energy	1.5%	3.5%	35%
	28,256 MW	2472 MW	2884 MW	33,613 MW
Rest of WECC	20%	0.9%	2.1%	23%
	36,767 MW	2895 MW	3378 MW	43,040 MW
Total	65,023 MW	5368 MW	6262 MW	76,654 MW

Tasks and Schedule

- Stakeholder Meeting (5/23/07)
- Data Collection (until 5/08)
  - Wind and solar mesoscale modeling (3TIER)
  - Utility load, generator, transmission data (Exeter)
- Preliminary Analysis (3-7/08) - GE
  - Extensive statistical analysis with various options for wind/solar sites and transmission
- Scenario Development (8/08) - GE
  - In-state vs out-of-state resources
  - Geographically diverse resources
  - Mega projects
  - Best correlated with load
- Stakeholder Meeting (8/14/08)
- Run Scenarios (starting 8/08) - GE
  - Examine costs due to regulation, load following, unit commitment
  - “Dives” to investigate issues such as Hoover
  - Examine mitigation strategies/options
  - Determine contributions to reliability and capacity value
- Preliminary Technical Results (end ‘08)
- Reporting and Stakeholder Meeting (mid ‘09)

Wind Data

- Previous data sets assembled from various years, measurements and assumptions
- Hired 3TIER to undertake largest wind mesomodeling to date
- Wind speed database (24TB)
  - Entire western US at 2km x 2km grid
  - 10, 20, 50, 100, and 200m hub heights
  - 10 minute intervals for 2004-6
- Wind power database (100's GB)
  - Selected 32,000 grid points
  - Each grid points holds 30 MW
  - Based on Vestas V90 3MW turbine and 3TIER's SCORE process
  - Hourly forecast for day-ahead wind output

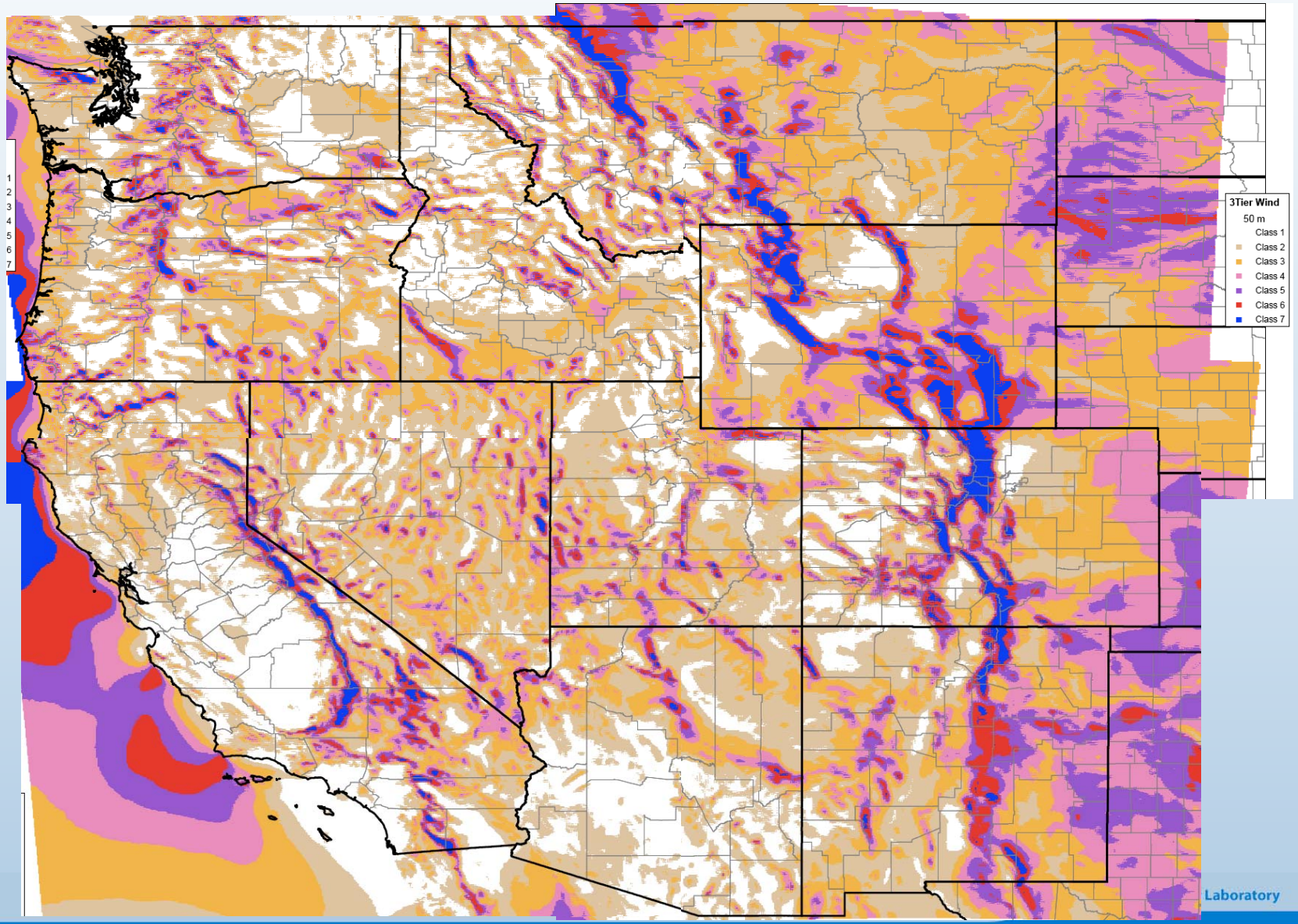
This database was designed for:

- Spatial and temporal comparisons of sites
  - Geographic diversity
  - Load correlation
- Estimates of power production from hypothetical wind plants
  - Investigating needs for storage based on wind variability
  - Examining potential transmission line loadings from hypothetical wind farms
  - Simple economic calculations comparing cost of delivered energy from in-state versus out-of-state

This database was not designed for:

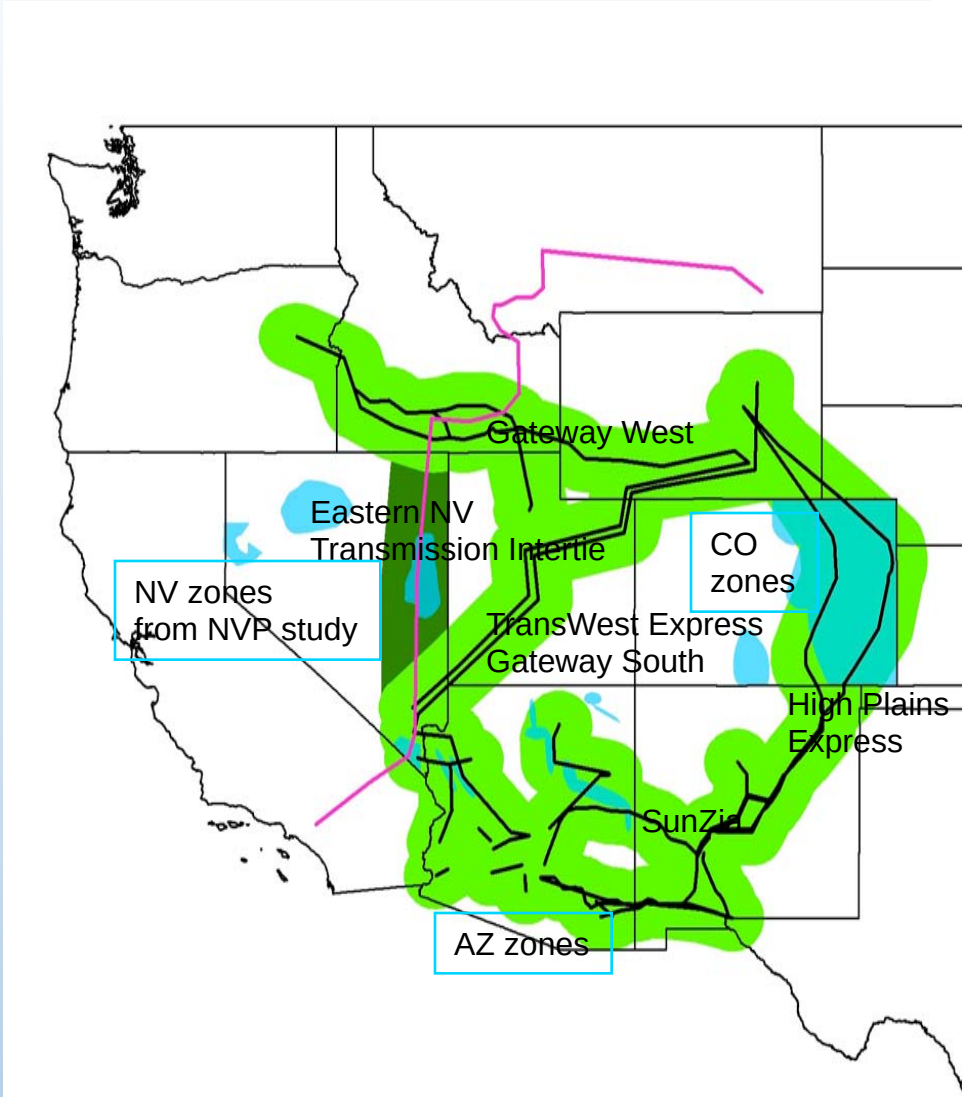
- Needs for high accuracy, absolute wind speed or power output
- Long-term average wind speed or wind power output
- This was not designed to be used as the only basis for investment. Ground-truthing modeled data with actual measurements is critical.

Average Wind Power Density 2006

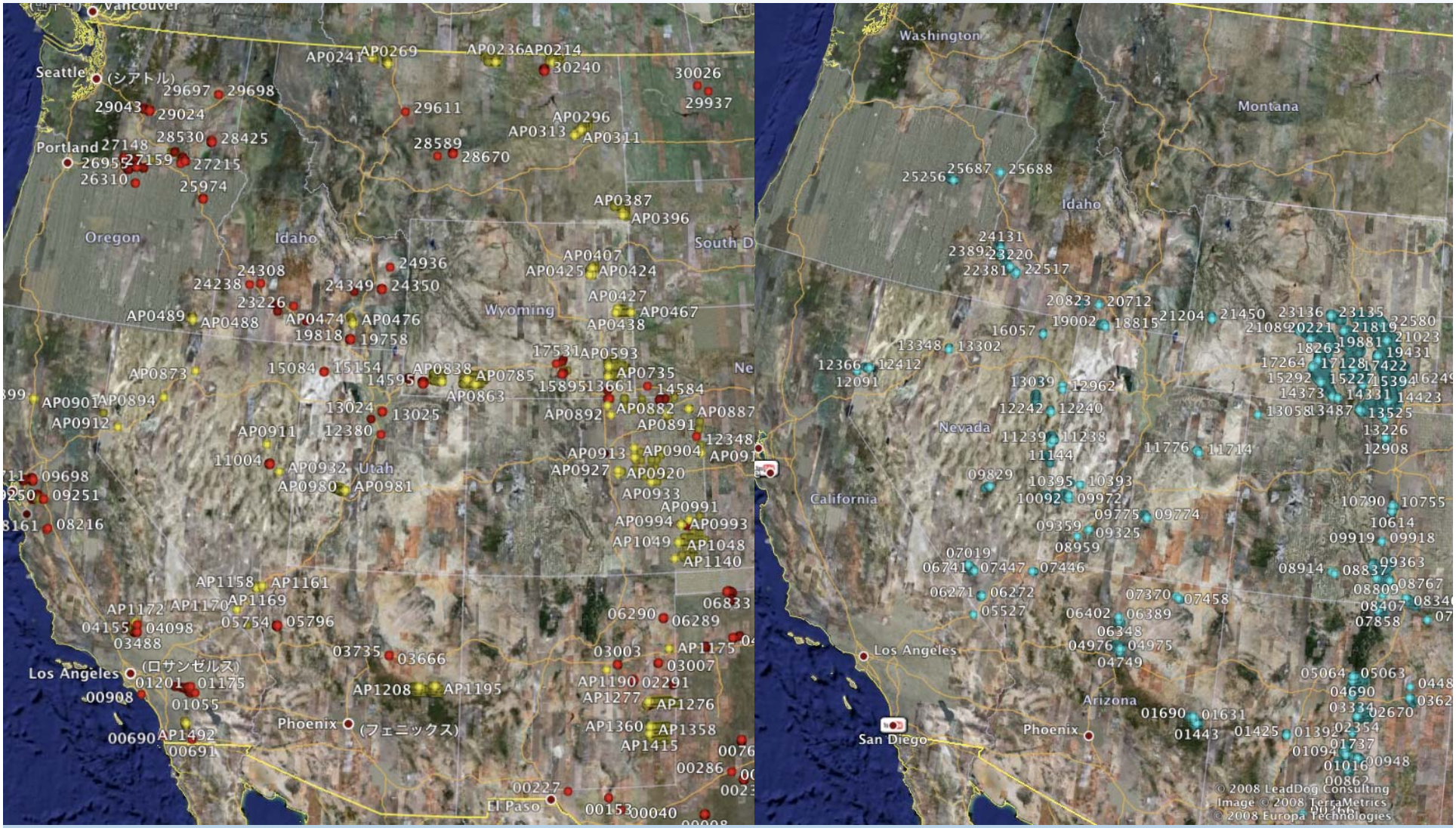


Site selection

- 3TIER downselected from 1.2M to 30,000 points. GE will select final sites.
  - Exclusions - recreation, urban, forests, slopes, high elevation, etc. (NREL)
  - Preselected sites - existing or planned wind plants (Platts database/NREL)
  - Transmission corridors or zones (200 GW) - based on proposed new transmission and initial zone information (excl new NV zones)
  - Load correlation (250 GW) - best diurnal correlation with Westconnect load
  - Best resource (450 GW) - best wind power density
  - Additional sites added in to help validate model results

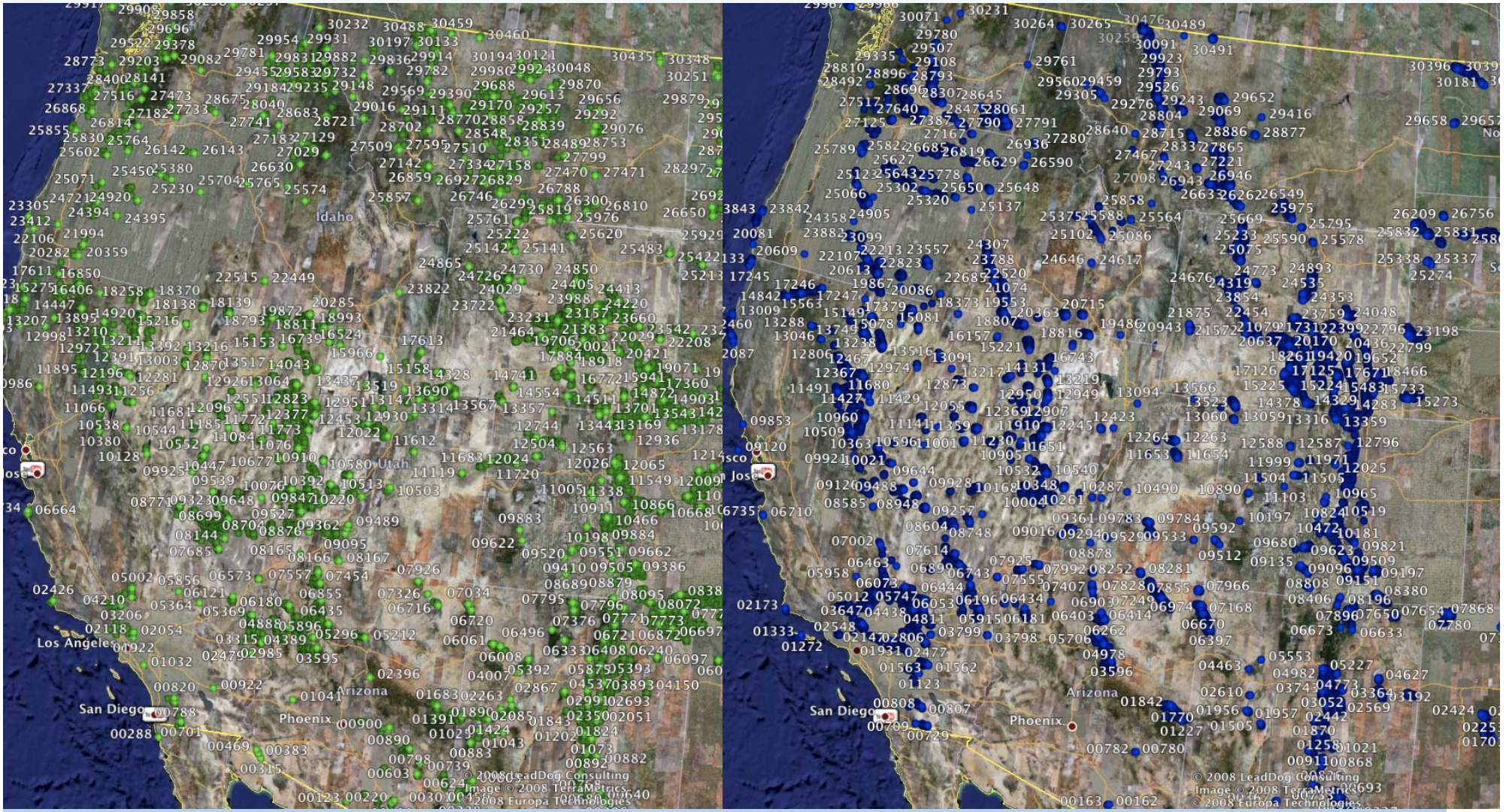


Preselected Transmission corridor/zone



Load correlated

Best resource



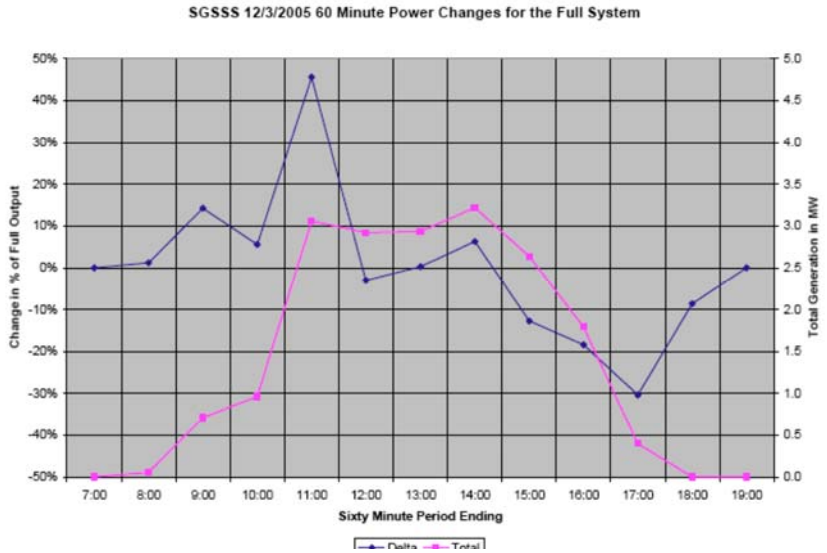
Web-based interface for wind data

- Similar to 3TIER's FirstLook ->
- Click on site and download 10 minute wind speed and wind power output data stream for selected periods
- Planned release in summer to be accompanied by webinars explaining use of database

Solar Modeling

- Perez of SUNY ran solar model for US
  - 10km x 10 km grid
  - 1 hour intervals for 2004-2006
  - Direct normal and global insolation
  - Available at http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/
- PV Modeling
  - By weather station site (150 sites for western US)
  - Template of different orientations and tracking configurations
- Concentrating Solar Power (CSP) Modeling
  - Parabolic trough plants with 6 hours thermal molten salt storage, similar to APS Abengoa plant
  - Modeled over 200 GW of CSP sites

Need for Subhourly PV Analysis



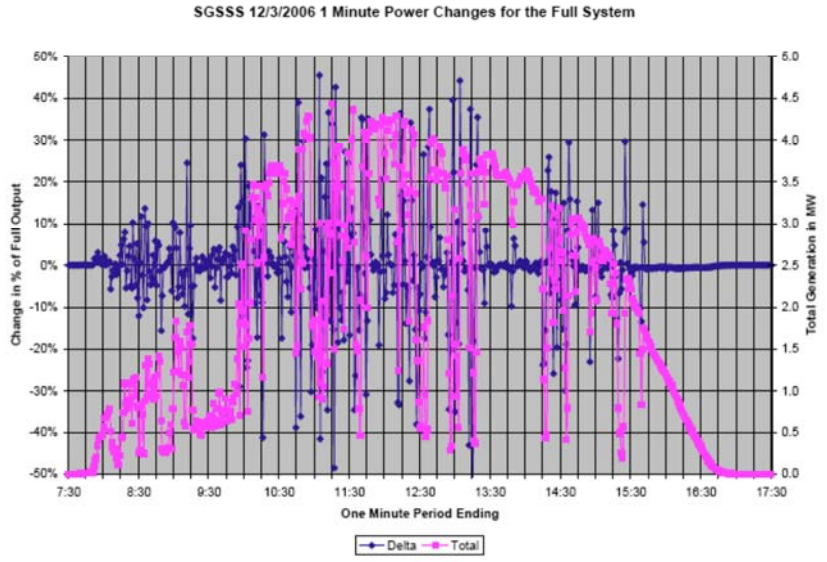
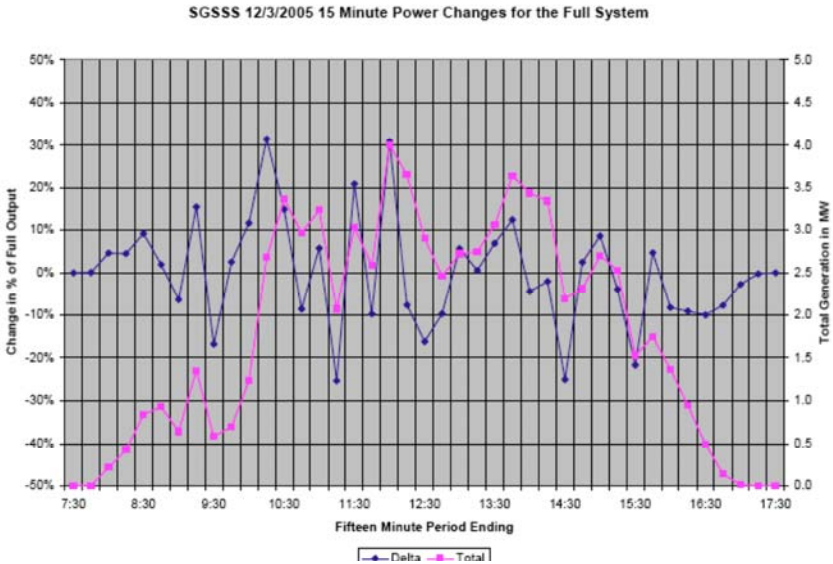
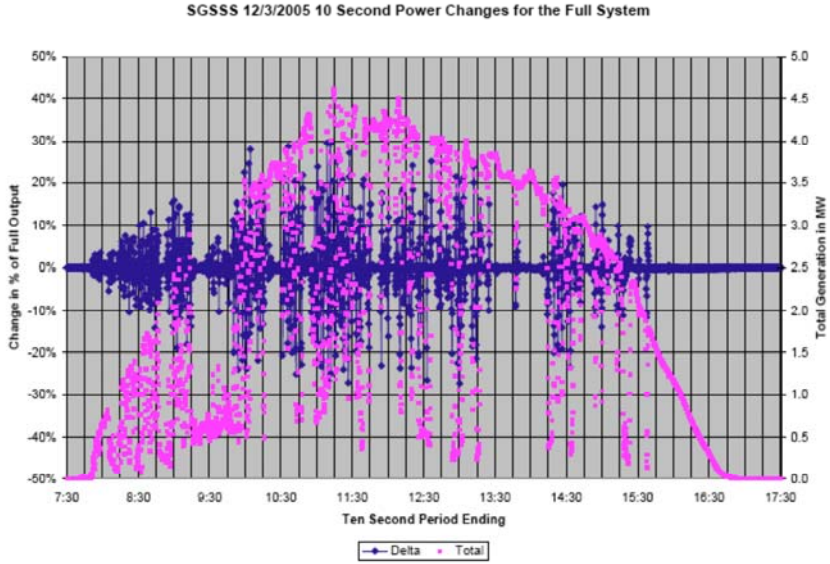


Figure 10





Source: Tom Hansen, Tucson Electric Power

Figure 11

Contact Information

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